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Pedicled Latissimus Flap for Scalp Defects - A Reliable Yet Less Used Reconstructive Option for Large Scalp, Temporal and Head and Neck Defects - Review of the Technique, Indications, Utility and Outcomes

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Abstract

Latissimus dorsi flap despite being a reliable and robust reconstructive option has found less than desirable mention in the reconstruction of defects following head and neck, scalp and skull base resections. While free flaps are used regularly following ablative defects there are issues related to the need for special microvascular expertise, financial constraints and additional morbidity that have not led to their universal acceptance for resurfacing defects after major resections of the scalp and head and neck region. Most cancer centers do not have access to sophisticated microvascular surgical infrastructure and therefore utilize Pectoralis Major Myocutaneous Flap (PMMF) commonly. Little do surgeons realize that PMMF are associated with serious morbidity affecting the shoulder joint and mutilation of breast which is resented by the female patient. The Pedicled Latissimus Dorsi Flap (PLDF) is a relatively under used alternative reconstructive option which if used judiciously may minimize the shoulder joint disability considerably and aid in the post-surgical rehabilitation. The only perceived limitation has been the need for patient repositioning to harvest the flap from lower back which in the past led to additional time during the surgical procedure. With regard to reconstruction of scalp defects, intubation is usually achieved in an operating trolley with patient in supine position and then the patient is shifted onto a prone position on the OR table with a special neurosurgical head holder that allows the endotracheal tube to exit below the head end of table without any kinking or obstruction to link with the adaptor that connects it to the ventilating anesthetic machine.

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Introduction

Posterior and posterolateral scalp defects arising from resection of malignant lesions in this area are unique as they have special unique dimensions, location and characteristics that make resurfacing a challenge. Most often they are cutaneous malignancies which are epithelial in origin such as squamous cancers, basal cell cancers, and malignant melanomas. Some have been linked to an actinic trigger as they occur in laborers who work bare headed in fields where their scalps are directly exposed to intense ultra violet solar irradiation. Most surgical resections need to include the underlying pericranium to consolidate deep clearance; the bare bone of the calvaria which does not accept a full/split thickness skin graft and hence proves a challenge to resurfacing options available which is essential if adjuvant treatment has to be instituted for oncological control. Additionally, resection of the calvaria bone may be needed to accomplish tumor- free deep margins; this may leave the dura exposed and endanger the underlying brain/venous sinuses to possible infection and trauma in addition to thus delaying prompt institution of adjuvant radiotherapy. Lymphatics from these malignant lesions with exception of basal cell lesions also drain into the nape of neck, and subtrapezoidal lymph nodes and often need to be addressed surgically to enhance loco regional control.

Head and neck reconstruction has evolved tremendously over the last few decades. Pedicled locoregional flaps were amongst the first workhorse flaps for reconstructing head and neck defects [1-3], but have largely been replaced by free flaps. As our understanding of surgical and anatomic considerations improve, microvascular free tissue transfer has become has gradually emerged as the gold standard for reconstruction with success rates around 95% [4-8]. However, there are many situations where pedicled loco regional flaps still have merit. In oncology patients at higher risk for thromboembolic events following microvascular anastomosis or those with vessel depleted necks owing to prior operative interventions, pedicled flaps present an appealing alternative to free tissue transfer. The low acceptably low complications rate, need for a re exploration and return to turn to the operating room, and reduced operative time are important considerations in the right clinical context specially in limited healthcare facilities available in low middle income countries [9-11].

When bulk of myofascial tissue is desired, the Pectoralis Major Myofascial Flap (PMMF) has been one of the most commonly used pedicled flaps since its original description by Aryan in 1979 [1,2]. Its robust tissue coverage, straight forward simple surgical technique, and reliability have all contributed to its widespread adoption [12,13]. Trapezius flaps were also described around that time, with the Lower Island Trapezius Flap (LITF) being first described in 1980 [14,15]. Due to its location and reach, its use has been mostly described for reconstructing posterior cervical and occipital defects. The PMMF carries significant donor site morbidity associated with the harvest and loss of muscle function from the pectoralis major. Besides, the donor site morbidity associated with trapezius flaps and the need for intraoperative repositioning has prevented its more ubiquitous use. An alternative option for broad myofascial tissue coverage is the Pedicled Latissimus Dorsi Flap (PLDF). The first description of a pedicled myofasciocutaneous flap for head and neck reconstruction was given by Owens [16] in 1955. In this study report, Owens and the team described the use of a PLDF for reconstructing a mandibular defect. Since that time, the PLDF has been described throughout the literature for its utility in head and neck, scalp and nape of neck, chest wall, and breast reconstruction. It has also been used as an alternative to PMMF or trapezius flaps with improved donor site morbidity when the ipsilateral PMMF has failed in an earlier attempt at reconstruction [17-24]. Previous concerns about patient positioning and its feasibility in an interdisciplinary two-teamed approach have limited its use in head and neck reconstruction, but recent descriptions have demonstrated the viability of a simultaneous harvest [21,22].

Anatomic considerations

The latissimus dorsi is a broad muscle that originates from the inferior thoracic spinous processes, thoracolumbar fascia, iliac crest, and inferior ribs. It inserts on the inferior aspect of the inter tubercular groove of the humerus through a thin tendon. Functionally it has been referred to as the back pectoral muscle, serving to adduct the arm, largely assisting the teres major and pectoralis major muscles. The vascular supply to the latissimus dorsi muscle is classically described by Mathes and Nahai as a type V muscle, with a single dominant pedicle arising from the thoracodorsal system, and smaller segmental perforators from the posterior intercostal and lumbar arteries [22,23]. For the use of PLDF in head and neck reconstruction, the terminal latissimus dorsi branch of the thoracodorsal artery serves as the primary pedicle. Although there can be significant variability in the relationship between take-offs for the angular and serratus anterior branches from the thoracodorsal artery, the terminal latissimus dorsi branch reliably enters the deep surface of the muscle approximately 6 cm distal to the inferior scapular border [24]. In addition, the thoracodorsal artery can be dissected out of the latissimus muscle to create a longer pedicle and ease the arc of rotation. An in vivo depiction of this vascular anatomy is shown below Figure 1.

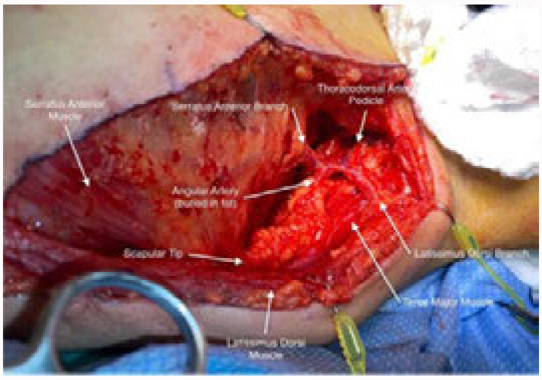

Figure 1: *In vivo* depiction of this vascular anatomy.

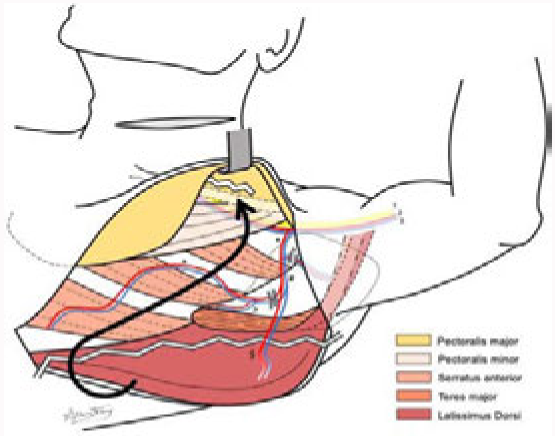

Figure 2: Anatomy of dissection for pedicled latissimus dorsi flap, demonstrating relevant muscular and neurovascular anatomy, including (*) subscapular, (^) circumflex scapular, (#) thoracodorsal, (>) angular, (+) serratus anterior, and ($) latissimus dorsi vessels. Also depicted are the brachial plexus (1), axillary artery (2), and axillary vein (3).

Positioning

Traditionally, a harvest of a free or pedicled latissimus dorsi flap has been described through intraoperative patient re-positioning or sequential surgery [25,26]. However, more recent descriptions have used a supine position to eliminate the need for repositioning and allow a two-teamed approach [27-29]. Traditionally, a harvest of a free or pedicled latissimus dorsi flap has been described through intraoperative patient re-positioning or sequential surgery [21,28,30,31]. However, more recent descriptions have used a supine position to eliminate the need for repositioning and allow a two-teamed approach [27-29]. The use of an upper extremity limb positioner (Spider Limb Positioner) to facilitate a simultaneous two teamed approach is described extensively by Stevens et al. [21]. This is achieved through positioning the patient on a bean bag in a semi-decubitus position while the Spider Limb Positioner holds the arm. For smaller patients with reduced body habit us, a soft decubitus position with the arm extended to 90 degrees on an arm board can also be sufficient for PLDF harvest without the need for a Spider Arm. This adaption of the intra-operative position has found favor at our centers. This is especially true when harvesting a myofascial flap alone. Incorporation of an overlying skin paddle may require brief retraction of the arm by an assistant to perform posterior cuts. When there is tension encountered for skin closure at the distal inferior part of the site a Thiersch graft can be conveniently harvested to close the defect.

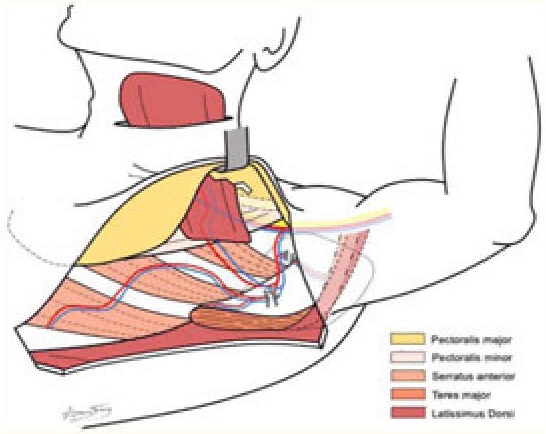

Figure 3: Anatomy of dissection for pedicled latissimus dorsi flap, demonstrating latissimus dorsi muscle flipped through a tunnel made in the pectoralis major muscle. Releasing the circumflex scapular pedicle allows for a significant arc of rotation.

Operative technique

With the arm in the proper position, the anterior border of the latissimus dorsi muscle can be easily palpated. This should approximate a line extending from the mid-axillary point down to a point between the anterior superior iliac spine and posterior superior iliac spine. The initial incision should be made at the inferior aspect of the anterior border of the latissimus dorsi muscle to prevent any inadvertent injury to the pedicle more superiorly. The inferior extent of the incision should be below the scapular tip and correlate with the length of the flap required to reach the primary defect. If a cutaneous skin paddle is harvested with the flap, careful skin paddle placement around the inferior aspect of the scapular tip is required to maximize the number of cutaneous perforators. After the initial incision, care is also taken not to shear the overlying subcutaneous tissue from the latissimus dorsi to preserve any musculocutaneous perforators.

Once the anterior border of the latissimus dorsi muscle is visualized, an avascular plane can be easily developed between the deep surface of the latissimus dorsi muscle and the serratus anterior muscle of the chest wall. Once this plane has been confidently established, the incision can be extended superiorly towards the axilla. The layer between the deep latissimus dorsi muscle and anterior chest wall can then be bluntly dissected to reveal the scapular tip, teres major muscle, and vascular anatomy of the thoracodorsal system (Figure 1). Depending on the patient body habitus, a variable amount of subcutaneous tissue should be bluntly dissected away from the vascular pedicle. Figure 2 depicts the anatomic view of this dissection. After identifying the latissimus dorsi branch, this segment of the muscle should be traced superiorly towards the subscapular system and its takeoff from the axillary artery and vein to maximize the PLDF arc of rotation. In our experience, it is important to take down the circumflex scapular veins to aid in pedicle rotation and confirm favorable geometry after rotation. The nerve to the latissimus dorsi will be intimately associated with the vascular pedicle and should be transected. Once the latissimus dorsi vascular pedicle has been confidently isolated, the angular and serratus anterior branches are ligated along with the circumflex scapular branch. Figure 3 demonstrates the ligation of these branches and subsequent muscular cuts used to isolate the latissimus dorsi from its inferior and humeral attachments.

Dissection is continued between the pectoralis major and minor muscles to create a tunnel through which the flap can pass to the neck. A cut is made through the attachment of the pectoralis major to the clavicle to connect the neck and chest tunnel. Once the vascular branches of the flap and muscular attachments are released, the flap can be passed through this opening as depicted in Figure 3.

Latissimus dorsi pedicled regional flap

The latissimus dorsi flap may also be employed as a pedicled flap, and can reach as high as the temporal region or even the vertex if the skin paddle is placed caudally enough. Success rates of 90% to 95% have been reported for pedicled latissimus dorsi flaps.

Indications for pedicled as opposed to free latissimus dorsi flaps include:

1. A vessel-depleted neck where the patient's anatomy, previous surgery and/or irradiation may not offer safe options for microvascular anastomosis

2. Prior use of the ipsilateral PMMF/trapezius flap that has failed or a recurrent cancer which after resection leads to a defect that cannot be reached by the PMMF

3. A patient's general health does not permit additional time and risk associated with a microvascular free flap

4. Microsurgical expertise is unavailable

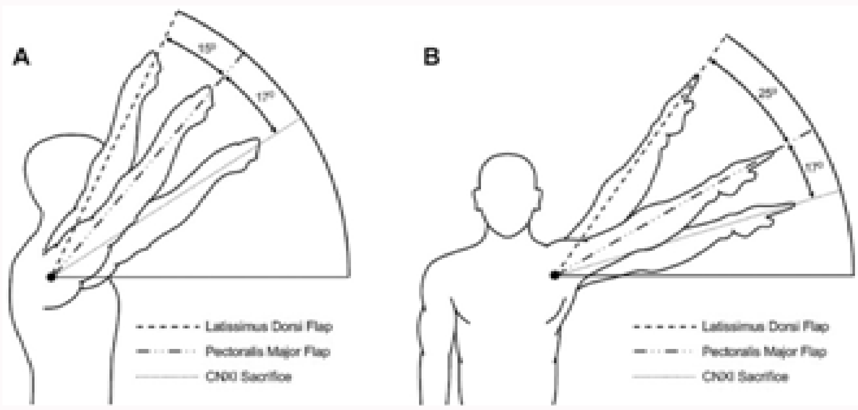

Figure 4: Relative deficits in passive shoulder flexion (A) and abduction (B) for latissimus dorsi donor site [20] pectoralis major donor site [35], and spinal accessory nerve (CNXI) sacrifice CNXI: spinal accessory nerve.

Discussion

Latissimus dorsi flap morbidity

The PLDF is a straightforward flap that can provide robust myofascial or myofasciocutaneous tissue coverage for multiple defects throughout the head and neck. Appropriate positioning and technique make a two-team approach possible, and the donor site morbidity of the PLDF is also favorable compared to other common pedicled myofascial donor sites. Multiple studies have investigated shoulder function following the sacrifice of the latissimus dorsi muscle [19,20,30-32,35]. Laitung and Peck describe one of the first objective assessments of shoulder function following the loss of the latissimus dorsi muscle as a free flap [20]. In that study, 13 of 19 patients had normal Range of Motion (ROM) in the affected arm, while the remaining 6 had some residual deficits in ROM (between 5° to 30°). Besides, 15 of 19 patients did not experience any subjective disability in their arm function.

These results are corroborated by more recent assessments of shoulder function following a latissimus transfer. Brumback et al. [32] analyzed the shoulders of 17 patients who had undergone removal of a vascularized latissimus dorsi muscle. None of these patients reported any impediments in performing activities of daily living, nor needed any modifications in sports-related activities because of shoulder dysfunction. When compared to healthy controls, there was no objective difference in shoulder adduction, internal rotation, external rotation, or pushdown. Only when the arms were held in 60° of flexion, forced extension was weaker than in healthy controls. However, this was not accompanied by any loss in ROM. Fraulin et al. [33,35] investigated the changes in muscle power and endurance for a group of 26 patients who had undergone pedicled or free latissimus muscle transfer. Fifteen of 26 had subjective difficulty with at least one activity since surgery, while only 4 of 26 had issues with a significant number of activities. The majority of these activities involved moving the arm above the head. Notable differences in power and endurance were seen for shoulder extension and adduction in females and males, however, patients did not see any additional deficits in work-simulated activities.

Trapezius and pectoralis major flaps- contrasting morbidities in relation to PLDF

Regarding trapezius flaps, both the LITF and UTF have been described for reconstructing a variety of defects within the head and neck, with a majority of instances occurring for posterior or lateral cranial defects. However, the associated morbidity for both flaps can be significant. For the UTF in particular, CNXI is typically sacrificed to increase the arc of rotation [19]. Although there is a paucity of objective analysis for shoulder and neck function following UTF, the resulting denervation of the trapezius and sternocleidomastoid muscles results in significant functional morbidity. Commonly referred to as "Shoulder Syndrome", the resulting limitation in neck movement, accompanying atrophy, chronic shoulder pain, and reduced ROM is commonly seen after radical neck dissections [31]. This functional compromise has caused the UTF to fall out of favor. Studies have shown significant functional deficits in shoulder function, range of motion, and quality of life metrics for patients who underwent a sacrifice of CNXI during radical neck dissections compared to those who did not [34]. Similar functional deficits are seen with the LITF, although to a lesser degree. Both chronic shoulder pain and dysfunction are common minor complications following LITF [18]. Here, the proximal CNXI is not necessarily sacrificed, however, smaller branches are at risk. The variable angiosomes of the trapezius muscle has questioned the reliability of LITF. The Transverse Cervical Artery (TCA) was thought to be the dominant pedicle to the trapezius; however, the Dorsal Scapular Artery (DSA) provides a major contribution to the inferior aspect of the muscle. The relationship of the TCA and DSA is highly variable and several anatomic variations exist where each can be the dominant vascular supply to the trapezius [16,17]. This anatomic variability, significant donor site morbidity, and the need for intraoperative repositioning to a decubitus or prone position have limited the use of both UTF and LITF to very specific clinical situations.

In contrast, the PMMF is still widely used for its reliability, consistent anatomy, and ease of harvest. However, shoulder dysfunction following a PMMF harvest can be significant. Both objective and subjective assessments of shoulder function following PMMF are scarce throughout the literature, but consistent in their assessment of shoulder dysfunction. Sun et al. [34] prospectively enrolled 46 patients undergoing PMMF and 46 matched control undergoing neck dissection only to assess changes in the Disability of the Arm, Shoulder and Hand (DASH) questionnaire at one year postoperatively. There was no significant difference in pre and postoperative DASH scores for the control group, while those undergoing PMMF saw a significant increase in postoperative DASH scores, nearly tripling their preoperative scores. Moukarbel et al. [35] demonstrated similar results in a comprehensive assessment of objective and subjective shoulder dysfunction in patients undergoing PMMF. In their work, a case-control study of 8 patients undergoing Total Laryngectomy (TL), Bilateral Neck Dissection (BND), and PMMF was compared to 10 patients undergoing TL and BND only. Objective analysis by a blinded physiotherapist demonstrated significant reductions in shoulder flexion angle and combined internal/external rotation angle for PMMF shoulders. A significant reduction in strength for shoulder flexion, external rotation, and adduction was also seen. Subjective assessments of shoulder function using the shoulder pain and disability index demonstrated a significantly higher disability score for those shoulders undergoing PMMF. Furthermore, physical analysis of the neck also demonstrated significant reductions in extension and total ROM on the ipsilateral side of PMMF. This was also confirmed on radiographic analysis, where total angular ROM was significantly reduced in the PMMF group when compared to controls. The PMMF flap does not have the arc of transposition to reach the scalp despite all attempts at increasing length of the pedicle. Furthermore, it has not found popular acceptance in the females as it causes breast mutilation and the cutaneous pedicle is thick, difficult to inset and tends to shear off the underlying muscle. In hairy males, the growth of hair has found to be unacceptable as it rarely matches the scalp hair.

Although there is a lack of objective data to represent shoulder dysfunction associated with trapezius flap donor sites, the sacrifice of CNXI can be used as a surrogate for UTFs. Figure 4 demonstrates relative deficits in passive shoulder flexion (Figure 4A) and abduction (Figure 4B) between the latissimus dorsi donor site, pectoralis major donor site, and CNXI sacrifice. While this does not account for various factors like flap size or scar contracture, these comparisons show the expected passive ROM deficits associated with these myofascial flaps [20,35]. Overall, the current literature suggests reduced donor site morbidity for the PLDF when compared to other similar myofascial flaps, robust scientific evidence is needed to fully assess and compare these deficits. Direct comparisons for donor site function after PLDF, PMMF, LITF, or UTF will help inform the appropriate reconstructive option for a given defect.

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